



In the past, when I have illustrated High Frequency (HF) radio signals reaching the ionosphere, I have always shown them as doing one of three things:

- being absorbed by it,
- passing straight through it and out into space,
- or being refracted forwards but downwards (i.e. basically continuing in the same direction).

A typical illustration of this is from the January 2018 *Making Waves*, shown here as **Fig. 1**. In this illustration the signal at the highest angle all escapes, while more and more signal is refracted back to earth at increasingly low angles. What I haven't mentioned before is a fourth possibility – HF signals being bounced back from the ionosphere in basically the direction they came from.

The Requirements

On the HF bands the level of ionisation needs to be quite high for signals to scatter backwards. Backscatter tends to occur on the upper HF bands during periods of high sunspot activity, i.e. in and around the peak of a Sunspot Cycle. The backscatter signals normally emanate from the F Layer of the ionosphere, although the E Layer can also be responsible for such signals.

Given that we are now approaching the end of Sunspot Cycle 24 (see **Fig. 2**), solar activity is low, the F Layer is not highly ionised and the upper HF bands are consequently in poor shape, Backscatter is unlikely. Some predictions suggest that Cycle 25 could start very soon but I am not convinced. Personally, I think Cycle 24 will bump along the bottom for longer.

The Big Picture

When stations operate on the HF bands, each of them has a personal 'Cone of Silence' around them, labelled in **Fig. 1** as the Skip Zone. It is also known as the Dead Zone. Irrespective of what you call it, it is something I discussed in detail in January 2017. **Fig. 3** shows what I wrote about then but in a simplified form. In this illustration, Cones of Silence (shown as coloured doughnut shapes) overlap. In this illustration Stations A and C can hear each other, as can stations B and C. This because they are not within the each other's Skip Zone. But Station B can't hear Station A (or vice versa), because although they are relatively close to one another, each is in the Skip Zone of the other. This is how HF propagation works in the nor-

Backscatter

Steve White G3ZVW looks at an uncommon mode of signal propagation, Backscatter.

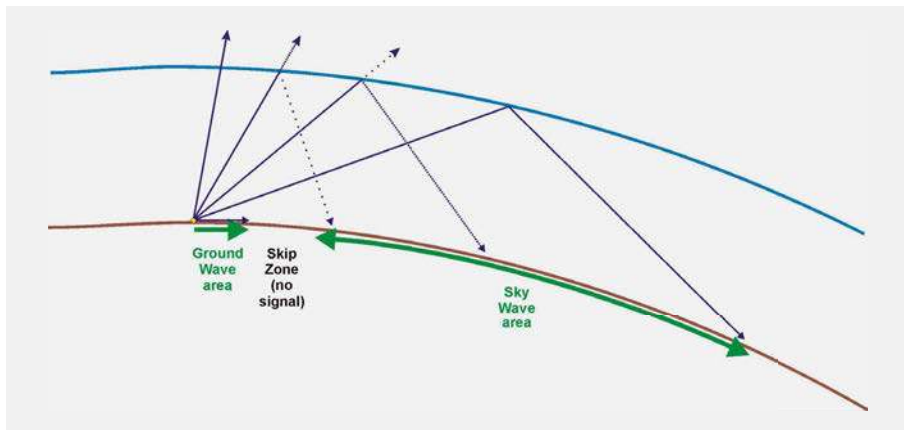


Fig. 1: Normal Skywave propagation.

mal scheme of things.

What I show in **Fig. 4** is that there can also be a scatter path between Station A and Station C but given the fact that scattered signals tend to be weak, they are likely to be overwhelmed by signals on the direct path. If there was a strong scattering path between A and C, it would explain an echo on the signal. This is because the signal paths are different lengths, so the scattered signal would arrive very slightly later than the direct signal. Two (or more) signal paths would also cause great difficulty in decoding for some datamodes. **Fig. 5** shows a side-on view of the same. To keep this illustration simple, I didn't show any signals to the left of the yellow dot that represents the station but a signal could scatter back from that side, as well as the right.

Irrespective of the direction that the second signal comes from, it is known as Multipath reception.

How to Know

So how are you likely to know that you are hearing a station on HF via Backscatter?

This first thing is to consider the likelihood of whether the station you are listening to is in the Skip Zone. On the upper HF bands the Skip Zone extends from a few tens of miles up to hundreds of miles. Under these circumstances you're

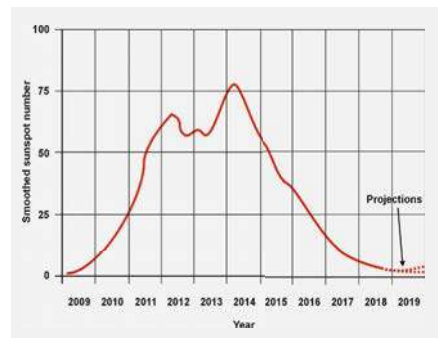


Fig. 2: The current state of the Sunspot Cycle.

just not going to hear anyone in your personal 'Cone of Silence' and it is one of the primary reasons why it is not uncommon to hear two stations from the same part of the world (or country) operating on the same frequency. You might be able to hear both of them clearly, just as Station C can hear Stations A and B, but if you happen to be Station A the effect of the Skip Zone means that you won't normally hear Station B (and vice versa – Station B cannot hear Station A). If Station A can hear Station B it is an indication something unusual is going on.

The second is the actual sound of the signals. Backscatter signals are usually quite weak. Also, they are likely to have a hollow sound to them. Sometimes they can also be accompanied by an echo, although I have never personally heard this.

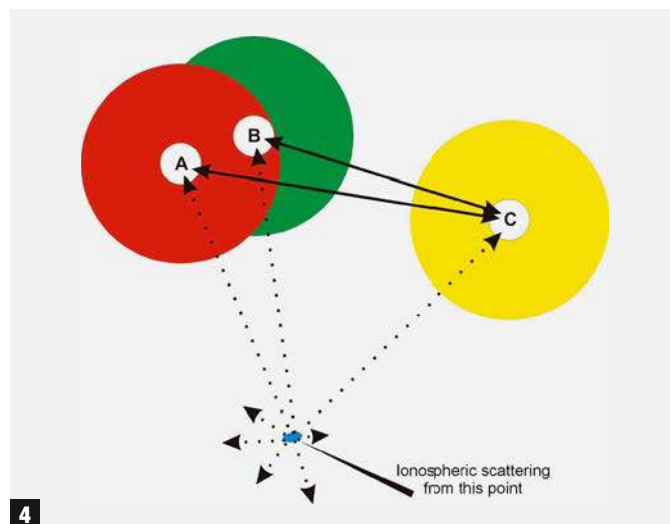
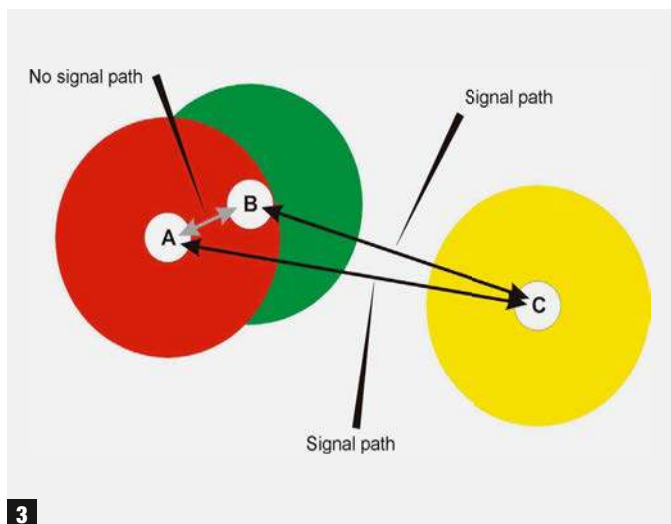


Fig. 3: A 'Cone of silence' surrounds each station on HF. **Fig. 4:** Overhead view of how Stations A and B are sometimes able to get a signal path by Backscatter.

How to be Certain

For the majority of us, equipped with maybe just a dipole antenna, it can be very difficult to be sure that a station is being heard by Backscatter. Those lucky enough to have a beam antenna, however, can be certain, by swinging their beam around from the direction that a straight (direct) path signal would take, to discover whether the signal from the other station gets stronger in a different direction.

From Ireland while I beaming to the US I have heard backscattered signals from stations in the UK, a distance that should be unworkable at HF. When I did so the signals were being scattered from somewhere out across the Atlantic, arriving in Ireland from pretty much the opposite direction that a direct signal would arrive. Something to note is that on another day or at another time, backscattered signals might arrive from a different direction.

Other Backscatter Modes

There are other types of backscatter

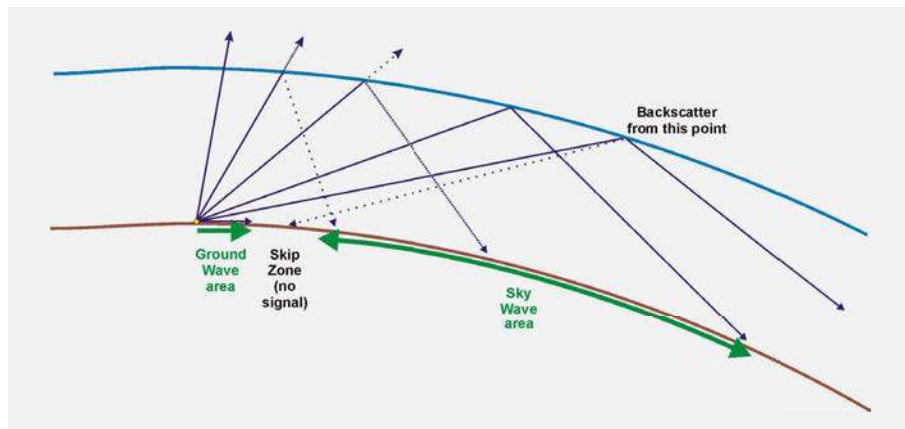


Fig. 5: Side-on view of how Stations A and B are sometimes able to get a signal path by Backscatter.

propagation I would like to briefly mention, the first being one that I devoted a whole feature to in September 2016 – Auroral. Auroras are pretty good at scattering VHF signals. They do it in all directions, the signals coming back sounding extremely distorted. The second is a very inefficient kind of backscatter mode that I intend to devote a feature to in the future,

Moonbounce. Earth-moon-earth (EME) propagation is where two stations each point highly directional VHF beams at the moon and make contact via signals reflected from it. A third, often employed by VHF/UHF and microwave DXers is aircraft scatter. For obvious reasons, this can only work intermittently as aircraft pass through the antenna's beam.

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